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ABSTRACT

This study examined the relationship of teacher and learning environment variables to attitude toward mathematics. A model explaining these relationships was hypothesized, and causal analysis was employed to test the truthfulness of the model. An Inventory of Affective Aspects of Schooling was developed which tapped various aspects of the five dimensions of the model: student motivation, teacher quality, social-psychological class climate, management-organization class climate, and attitude toward mathematics. Over 2,000 students in grades 4, 7, and 9 were surveyed. Support for the model was moderately positive with the fourth-grade sample, but improved substantially at grades 7 and 9. (MNS)

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A Causal Analysis of Attitude Toward Mathematics

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Running Head: A Causal Analysis of Attitude

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Abstract

The purpose of this study was to examine the relationship of teacher and learning environment variables to attitude toward the school subject of mathematics. A model explaining these relationships was hypothesized, and causal analysis was employed to test the truthfulness of the model. Support was moderately positive with a grade four sample, but improved substantially at grades seven and nine.

A Causal Analysis of Attitude Toward Mathematics

There have been several extensive reviews of research on attitude toward mathematics (Aiken, 1970, 1976; Kulm, 1980; Shaughnessy, Haladyna, Olsen, & Shaughnessy, 1981). The latter review revealed that the preponderance of research has concentrated on the association between mathematics attitude and (a) achievement, (b) intelligence, (c) family background, and (d) innovative programs, while few studies have dealt with (e) teacher and (f) learning environment variables.

In most studies reviewed, the unit of analysis was the individual. This approach has been criticized because the social context of the class is ignored. For example, Lavin (1965) has protested that in studies where the individual is the unit of analysis, we are treating students as if they were in a vacuum by ignoring class effects. Getzels (1969) suggests that the classroom environment and the group atmosphere may prove to be among the most powerful indicators of student outcome variables. Moos and David (1981) have stated that the class is a micro-climate with its own class characteristics. Therefore, it seems suitable to perform analyses at the class level, because changes in instruction probably have a more pervasive affect on classes of students than they do on the individuals that comprise the class.

Perhaps the most compelling argument for studying class effects is that most classrooms are organized in such a way as to produce class effects. While it is known that certain factors such as aptitude, achievement, gender and motivation are known to correlate to some extent with student attitude toward mathematics, some of the more prominent, yet virtually unstudied variables are measured at the class level and may have the most telling effects at this level. These variables include teacher quality and the learning environment.

All of these reviews of research have discussed two other problems: (a) the absence of theoretical models for the study of attitude, and (b) the lack of integrative findings about potential determinants of mathematics attitude.

The present study was performed in the context of an emerging model for explaining causal determinants of attitude toward mathematics. The study was also designed to tap teacher and learning environment variables that were believed to be the most powerful causal determinants of mathematics attitude.

Definition of Attitude Toward Mathematics

Attitude toward mathematics is defined as a general emotional disposition toward the school subject of mathematics. This is not to be confused with attitude toward the field of mathematics, with one's ability to perform in the field of mathematics, or attitude toward some specific area within mathematics (e.g., geometry, word problems).

Generally, attitude toward mathematics (as well as any other subject matter) is valued for the following reasons:

1. Attitude is an important school outcome in and of itself;

2. Attitude is often positively, although slightly, related to achievement; and

3. Positive attitude toward mathematics may promote increases in the numbers of students who elect mathematics courses in high school and college, not to mention elect careers in mathematics or mathematics-related fields.

A Model for the Study of Attitude Toward Mathematics

To assist in conceptualizing the school factors which could be examined, a model was posited to describe the relationship believed to exist between attitude and other classroom variables (see Figure 1). In this model, a class's attitude toward mathematics was seen as part of a bigger concern in

Insert Figure 1 about here

school, namely, motivation. Attitude toward mathematics is described, therefore, as one of a constellation of variables included in a student motivational level.

The model also hypothesizes that attitude development may be influenced by a number of factors occurring both in and outside the school setting. While the model recognizes that exogenous factors (those derived outside of school), such as student gender, social class, scholastic aptitude, may contribute to attitude formation, these factors were not included in the present study for two reasons. First, these exogenous variables reside outside the educators' sphere of immediate influence in school settings. Secondly, earlier analysis of data collected on attitude toward mathematics suggested that these exogenous variables have limited relationship to attitude (Haladyna & Shaughnessy, 1980; Shaughnessy, Haladyna, & Shaughnessy, 1981). The model, therefore, concentrates on the effects of the endogenous variables or those within the school setting which are seen as alterable (Bloom, 1980). It posits that the development of attitude toward mathematics is likely to be influenced by teacher and learning environment (sometimes referred to as classroom climate variables).

The problem that confronted the researchers was to identify these endogenous variables, and to estimate the strength of their effects on attitude toward mathematics. The mapping of these variables is described in the next section, but for the present we will identify the major constructs of the model, later providing some examples of items used to measure each variable.

We may conceptualize a class attitude, the mean of all individual measures of attitude for each class, varying as a function of several factors, namely, (1) teacher quality, (2) the social-psychological classroom climate,

and (3) the management-organization classroom climate. Class levels of motivation can be conceptualized as another important outcome variable, like attitude, which is more enduring in nature (Nicholls, 1979) and which can be complexly defined. Some aspects of motivation include (a) a general regard for the importance of the subject matter being studied, (b) self-confidence in ability to learn that subject matter, and (c) fatalism--the tendency to accept the fates as determining some outcome related to that subject matter. There are ample references to such traits in a wide variety of literature. In general, the latter term, fatalism, is interpreted negatively, as no matter what one does, mathematics is a disagreeable subject. Brookover, Beady, Flood, Schweitzer, and Wisenbaker (1979) refer to this trait as "futility." These three factors have been found to be highly interrelated (Shaughnessy, Haladyna, Olsen, & Shaughnessy, 1981), and Parsons (in press) has provided a more complex definition of motivation which encompasses these three factors.

In summary, the model implies that teacher quality and the social-psychological and management-organization climates affect student attitude, and each of these has a lesser affect on motivation, which is viewed as a more complex trait and as more resistant to change as a result of classroom practices. Therefore, the major objective of the present study was to explore the potential for these teacher and learning environment constructs to predict mathematics attitude at various educational levels.

Method

In experimental studies, there is direct control of subjects and causal determination can be made. In a natural setting, no such causal inference is possible. However, in a non-experimental setting causal relationships can be studied by first postulating relationships among variables and then testing these hypotheses in light of observations, using appropriate analyses. Causal

modeling is intended to reveal direct and indirect effects of factors which are believed to be causally related (Asher, 1976; Blalock, 1968; Woefle, 1980).

Sample

Over 2,000 students in grades four, seven, and nine participated in this study. The sample varied widely with respect to family mobility, socioeconomic status, television viewing habits, and school attendance. The sample did not vary much with respect to family background, as only 10.4% to 14.3% were listed as non-white, depending on grade level.

The sample was drawn by using a stratified, random sampling plan which controlled for size of district and size of school at each grade level as well as region of a state. The intent was to sample from schools that widely represented urban and rural locales and various school environments.

Instruments[1]

An instrument was developed which tapped various aspects of the five dimensions of the model: (a) student motivation, (b) teacher quality, (c) social-psychological class climate, (d) management-organization class climate, and (e) attitude toward mathematics. The result was the Inventory of Affective Aspects of Schooling (IAAS). The origins of the items and scales are varied. For example, the attitude scale was adapted from the TREAT (Haladyna & Thomas, 1979a, 1979b) which has been found to be highly construct valid for reliably measuring attitude toward mathematics. Scales were developed by selecting items from two well-known classroom climate inventories, the Learning Environment Inventory (Anderson & Walberg, 1976) and the Classroom Environment Scales (Moos & Trickett, 1974). Many exogenous variables and other scales were adopted or adapted from earlier research instruments or taken from the National Assessment of Educational Progress' numerous item collections. Sample items from each scale are listed in Table 1 along with

the identity of the construct they were supposed to represent. More information about these scales may be obtained from a manual provided by the authors.

Insert Table 1 about here

Procedures

Written permission to conduct the research was obtained from district administrators. A test administrator, trained in the use of the IAAS, visited the classroom and administered the instrument. The teacher was asked to leave the classroom during the testing. For grade four, items were read to all students. For grades seven and nine, the IAAS was self-administered. Individual assistance was offered for those who experienced difficulty in the reading of items.

Data were eliminated from students who chose not to participate or who completed only a part of the inventory. Most students participated in the exercise and cooperated. All responses were anonymous to encourage honest responding and insure confidentiality.

Analysis of Data

Class attitude toward mathematics, the dependent variable, was examined in relationship to student motivation (SM), teacher quality (TQ), the social-psychological class climate (SP), and management-organization class climate (MO).

To investigate the validity of this model to explain causal determinants of mathematics attitude, the technique of path analysis was used (Woefle, 1980). This procedure is useful for examining hypothesized direct effects of these constructs as well as their indirect effects. A causal order is assumed, and causal closure must be satisfied. The direction of causality must be stated and covariation must be closed to outside influences.

Statistically, ordinary least-squares regression analyses are used to estimate path coefficients (standardized regression or beta [B] coefficients). Later these path coefficients are used in structural equations along with correlation coefficients to determine the indirect effects that we might attribute to other factors in the model. The general theorem is used to develop these structural equations:

$$r_{ij} = \Sigma p_{ig} r_{jg}$$

where i and j are variables in the model and g exists over all variables with paths leading directly to Xi.

Results and Discussion

Table 2 provides correlations of each independent variable with student motivation (SM) and attitude toward mathematics (AM). These correlations ranged from .28 to .77, all but one statistically significant when using one-tailed tests and setting alpha at .05. The lower coefficients are reported for grade four where the two aspects of the learning environment were not satisfactorily mapped and reliabilities were lower.

Insert Table 2 about here

In general, these findings suggest strong associations between teacher quality measures as well as attitude toward mathematics and student motivation. For the relationship between the social-psychological dimension, the relationship increases as a function of grade level. This trend reverses for the management-organization dimension of the learning environment in relation to attitude toward mathematics. Relations with the motivation measure vary without much pattern. In general, teacher quality and the social-psychological factor are most consistently related to motivation.

In path analysis, we can explore causal relationships in an exploratory way by examining direct and indirect effects. A general interpretation for a direct effect would be that a path coefficient (the standardized regression coefficient or beta) represents the degree of causal effect of the independent variable on the dependent variable. If a path coefficient is .50, we might interpret this as a standard deviation increase in X would produce a .50 standard deviation increase in Y. This is a fairly sizable effect, and as a convention for interpreting path coefficients, .400 to .500 will be taken as a moderate effect, and anything above .500 will be taken as a sizable effect.

While path coefficients represent direct causal pathways, indirect effects are estimated from structural equations employing these path coefficients and correlation coefficients. A general interpretation is that a large indirect effect signifies that although a correlation may be high, the causal influence is mediated through other factors which are often defined in the model. In this instance, indirect effects plus direct effects were generally equal to the correlation coefficient.

The results of the path analyses for the three grade levels studied appears in Figure 2. Each result is discussed by the grade level.

Insert Figure 2 about here

Grade four. At this grade level, we were working under the limitation of an abbreviated instrument which resulted in an incompletely defined learning environment. The general finding here was that the primary dependent variable, attitude toward mathematics, was not significantly affected by any variable. The path coefficients were small indeed, but suggested that attitude toward mathematics was most heavily influenced by the social-psychological

climate of the classroom and less influenced by teacher quality and the management-organization climate.

The student motivation variable was most heavily influenced by teacher quality, however, and very slightly influenced by other measures. As hypothesized, teacher quality was mediated by the two learning environment variables in terms of its affect on attitude toward mathematics. The teacher quality effect was the second largest observed for the fourth grade classes. The effect of teacher quality on the management-organization dimension, which is task difficulty in this instance, was very great. This leads to the notion that when classrooms are well organized, well managed, and the teacher is perceived as effective, class perceptions of task difficulty are such that classwork is perceived as easy. This is in direct concurrence with the Beginning Teacher Evaluation Study (Fisher, Berliner, Filby, Marliave, Cahen, & Dishaw, 1980) where task difficulty was correlated with achievement and other factors of effective teacher.

Grade seven. Results for this level were more definitive due to higher correlations with the dependent measures, a more definitive mapping of the learning environment dimensions, and higher reliabilities of the variables.

Path coefficients between each of the independent variables and attitude toward mathematics varied, but yielded moderate effects for the management-organization dimension and teacher quality. The social-psychological dimension was not highly related to mathematics attitude. The teacher quality measure was somewhat mediated by management-organization, again illustrating the close functional relationship between the two--a finding at grade four as well. A stronger influence was noted between teacher quality and the social-psychological dimension.

Attitude toward mathematics was moderately related to student motivation at this level as was the social-psychological dimension, but these fell below

expectations. Student motivation may be more resistant to present classroom influences, and these data seem to support such a conclusion.

Grade nine. Attitude toward mathematics seemed to be strongly influenced by teacher quality and the social-psychological dimension, indicating a shift to social aspects of schooling in relation to attitude and the consistent growth of teacher quality as a factor in attitude. Management-organization dimension dropped greatly in significance here, but seemed to be more influential with the student motivation dimension. The relationship between attitude and motivation was quite strong (B = .579). Both the social-psychological dimension and attitude seemed to be the most potential causal variables for this motivation dimension, suggesting a strengthening of a trend established at grade seven.

To summarize these findings, we should examine the potency of each of the three constructs. Teacher quality appears to be a potential influence of the management-organization dimension of schooling at all grade levels, but these data would suggest that this management-organization factor is not very influential on attitude toward mathematics and student motivation.

Some mediation of teacher quality, through management-organization, is suggested in the earlier grade levels, but by grade nine, this tendency disappears.

The social-psychological dimension has some importance in grade four, loses its value in grade seven and makes a minor comeback at grade nine. A stronger case exists for the influence of the social-psychological dimension on student motivation.

With respect to the influence of attitude on motivation, the trend strengthens as a function of grade levels with path coefficients increasing from .103 to .399 to .579 at the respective grade levels studied.

Conclusions and Implications

While this research has been exploratory in examining the potential for causal relationships among some major constructs of schooling that have not been previously studied in relation to mathematics attitude, some evidence has been presented which suggests that:

1. Teacher quality, as determined from student self-reports, does seem to be consistently related to mathematics attitude at all grade levels, as well as to student motivation.

2. Management-organization, while well defined at grades seven and nine and rather poorly defined at grade four, showed little impact on both mathematics attitude and student motivation. Undeniably, there is a strong link between teacher quality and management-organization, but no strong effects seem to exist.

3. The social-psychological dimension appears to have its greatest influence at grades four and nine on mathematics attitude, with a lessening influence at grade seven, where the former two dimensions have a greater prominence. This shift may be correlated with developmental changes that occur in junior high students who undergo signficant changes in their learning environments as they move from self-contained learning environments to departmentalized ones.

It seems reasonable to assume that if studies like this one are replicated in grades six through nine, and results tabulated as a function of the type of school organization (self-contained versus departmentalized), we might be able to reveal the effect of this transition in school life.

A more important implication of this research is that such factors as defined in this study are easily assessable through the use of easily administered student self-report instruments. The reliabilities are satisfactory,

and the instruments can provide some indexes of success in various aspects of school life that may be causally related to affective outcomes, such as those presented in this study.

Researchers and school practitioners interested in assessing causal factors such as those defined in various models of school learning, such as Bloom's (1976), the BTES model (Fisher et al., 1980), and Walberg's productivity model (1980), will find that those constructs defined here are very closely reflective of elements of each model. As we further refine such measures, they should become part of school programs for assessment and, eventually, program improvement.

References

Aiken, L. R., Jr. Attitudes toward mathematics. Review of Educational Research, 1970, 40(9), 551-596.

Aiken, L. R., Jr. Update on attitudes and other affective variables in learning mathematics. Review of Educational Research, 1976, 46(2), 293-311.

Anderson, G. J., & Walberg, H. J. The assessment of learning environments: A manual for the learning environment inventory and the my class inventory. Chicago, Illinois: University of Illinois, 1976.

Asher, H. B. Causal modeling. Beverly Hills, CA: Sage Publications, Inc., 1976.

Blalock, H. M., Jr. Theory building and causal inferences. In H. M. Blalock & A. B. Blalock (Eds.), Methodology in social research. New York: McGraw-Hill, 1968.

Bloom, B. S. Human characteristics and school learning. New York: McGraw-Hill Book Company, 1976.

Bloom, B. S. The new direction in educational research: Alterable variables. Phi Delta Kappan, 1980, 61(6), 382-385.

Brookover, W., Beady, C., Flood, P., Schweitzer, J., & Wisenbaker, J. School social systems and student achievement: Schools can make a difference. Brooklyn, N.Y.: J. F. Bergin Publishers, Inc., 1979.

Fisher, C. W., Berliner, D. C., Filby, N. N., Marliave, R., Cahen, L. S., & Dishaw, M. M. Teaching behaviors, academic learning time, and student achievement: An overview. In C. Denham & A. Lieberman (Eds.), Time to learn. Washington, D.C.: National Institute of Education, 1980.

Getzels, J. W. A social psychology of education. In G. Lindzey & E. Aronson (Eds.), The handbook of social psychology (Vol. 5). Reading, Mass.: Addison-Wesley, 1969.

Haladyna, T., & Shaughnessy, J. Attitudes toward science: A quantitative synthesis. Manuscript submitted for publication, 1980. (ERIC Document Reproduction Service No. ED 194 316)

Haladyna, T., & Thomas, G. The affective reporting system. Journal of Educational Measurement, 1979, 16(1), 49-54. (a)

Haladyna, T., & Thomas G. The attitudes of elementary school children toward school and subject matters. The Journal of Experimental Education, 1979, 48(1), 18-23. (b)

Kulm, G. Research on mathematics attitude. Journal for Research in Mathematics Education, 1980, 11, 356-381.

Lavin, D. E. The prediction of academic performance: A theoretical analysis and review of research. New York: Russell Sage Foundation, 1965.

Moos, R. H., & David, T. G. Evaluating and changing classroom settings. In J. L. Epstein (Ed.), The quality of school life. Lexington, Mass.: D. C. Heath and Company, 1981.

Moos, R. H., & Trickett, E. J. Classroom environment scale: Manual and Form R. Palo Alto, CA: Consulting Psychologists Press, Inc., 1974.

Nicholls, J. G. Quality and equality in intellectual development: The role of motivation in education. American Psychologist, 1979, 34(11), 1071-1084.

Parsons, J. E. Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), Assessing achievement. San Francisco: W. H. Freeman, in press.

Shaughnessy, J., Haladyna, T., Olsen, R., & Shaughnessy, J. M. Student attitudes toward math: A meta analysis. Manuscript submitted for publication, 1981.

Shaughnessy, J., Haladyna, T., & Shaughnessy, J. M. Determinants of class attitudes toward math. Manuscript to be submitted for publication, 1981. ERIC Document Reproduction Service No. ED 201 504)

Walberg, H. J. A psychological theory of educational productivity. In Frank H. Farley & Neal Gordon (Eds.), Perspectives on educational psychology. Chicago and Berkeley, CA: National Society for the Study of Education and McCutchan Publishing, 1980.

Woefle, L. M. Strategies of path analysis. American Educational Research Journal, 1980, 17, 183-210.

Footnotes

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[1]Copies of both versions of the instrument and the manual can be obtained from Tom Haladyna, Teaching Research, Monmouth, Oregon, 97361.

Table 1

Sample Items and Reliability Estimates for the Variables of the Study

Aspects	Sample Item	Scale Reliability Estimate		
		Four	Seven	Nine
Student Motivation (SM)				
Academic Self-Concept	I think that I am a successful student	.71	.76	.79
Importance of Mathematics	Math is a worthwhile and necessary subject	-	-	-
Fatalism	I'm not the type to do well in math	.52	.67	.60
Teacher Quality (TQ)				
Enthusiasm	My teacher likes math	.55	.50	.52
Respect	My teacher knows a lot about math	.64	.68	.77
Commitment to Help Students Learn	My teacher appreciates our work	.75	.76	.81
Providing Individual Attention	My teacher makes things worse when I have a problem	.56	.65	.62
Fairness	My teacher is fair to me	.70	.73	.75
Praise and Reinforcement	My teacher tells me when I do good work	.72	.80	.80
Social-Psychological (SP)				
Enjoyment of Classmates	How much do you like the students in your class?	.58	.53	.49
Environment	The students would be proud to show the classroom to a visitor	-	.51	.47
Cliqueness	Certain students stick together in small groups	-	.43	.42
Friction	There is a group of students that interfere with class activities	.67	-	-

(Continued)

Table 1, Continued

Aspects	Sample Item	Scale Reliability Estimate		
		Four	Seven	Nine
Management-Organization (MO)				
Speed	The class has plenty of time to cover the assigned work	-	.44	.72
Goal Direction	Most students know the goals of the course	-	.36	.55
Disorganization	The class is well organized	-	.77	.79
Materials Usage	We have good materials to read for this class	-	.54	.52
Attitude Toward Mathematics (AM)		.90	.79	.78
How do you feel when				
a. it is time for math?				
b. during math?				
c. when math is over?				
d. if you knew you would never go to math again?				

Table 2

Correlations Between Dependent and Independent Variables

	Student Motivation (SM)			Attitude Toward Mathematics (AM)		
	Four[1]	Seven[2]	Nine[3]	Four[1]	Seven[2]	Nine[3]
Teacher Quality (TQ)	.71	.54	.71	.40	.74	.77
Social-Psychological (SP)	.58	.67	.63	.28	.55	.64
Management-Organization (MO)	.36	.53	.51	.44	.72	.66

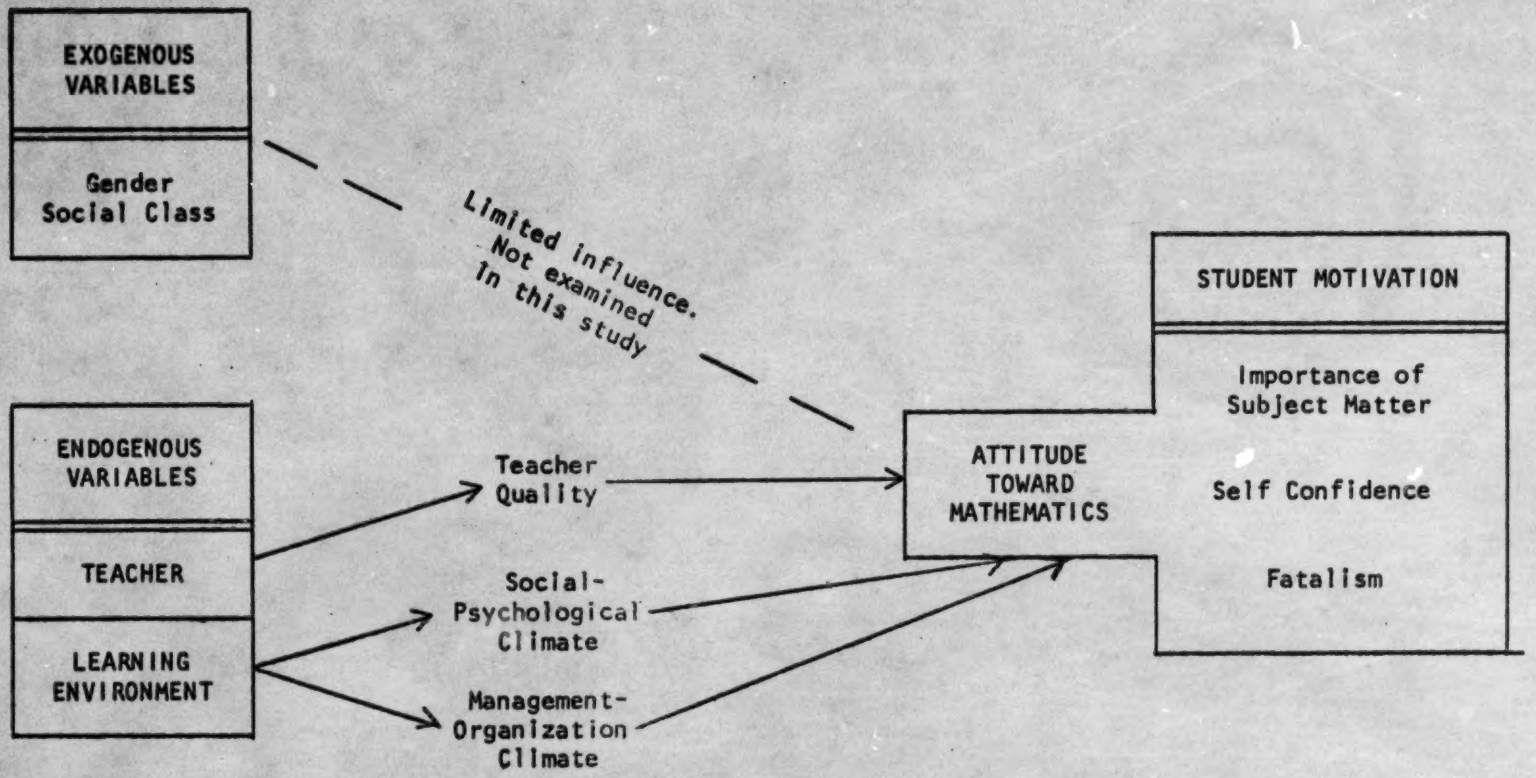
[1] ($N = 24$, $r = .32$, $p < .05$) for a one-tailed test.

[2] ($N = 34$, $r = .28$, $p < .05$) for a one-tailed test.

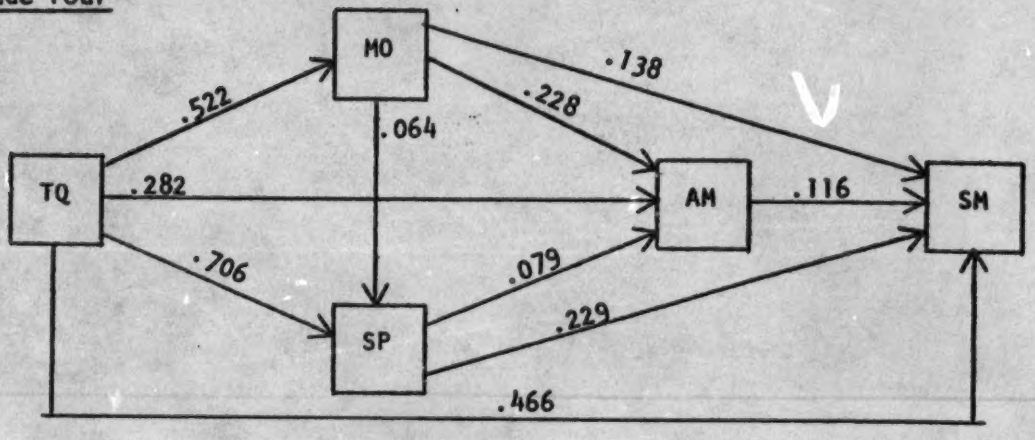
[3] ($N = 38$, $r = .27$, $p < .05$) for a one-tailed test.

Figure Captions

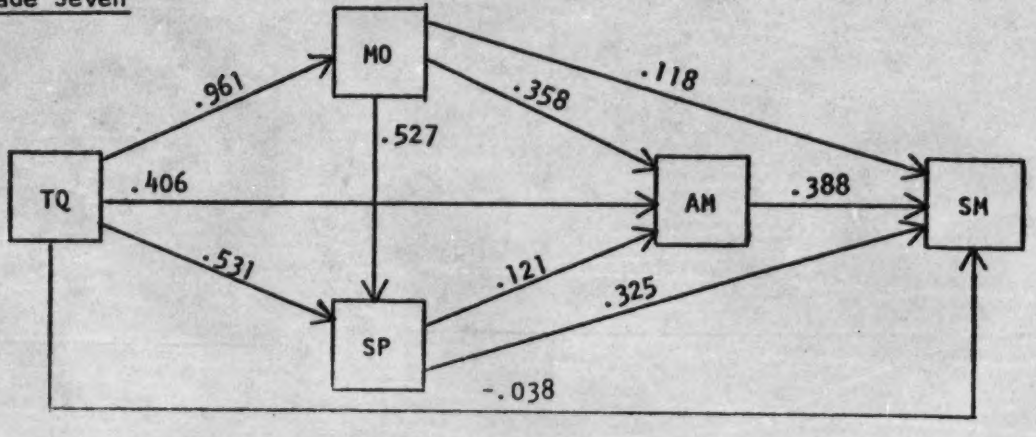
1. *A model for the study of attitudes toward mathematics.*
2. Results of path analysis for each grade level studied.


EXOGENOUS VARIABLES
Gender
Social Class
Limited influence. Not examined in this study
STUDENT MOTIVATION
Importance of Subject Matter
Self Confidence
Fatalism
ENDOGENOUS VARIABLES
TEACHER
LEARNING ENVIRONMENT
Teacher Quality
Social-Psychological Climate
Management-Organization Climate
ATTITUDE TOWARD MATHEMATICS

Grade Four



Grade Seven



Grade Nine